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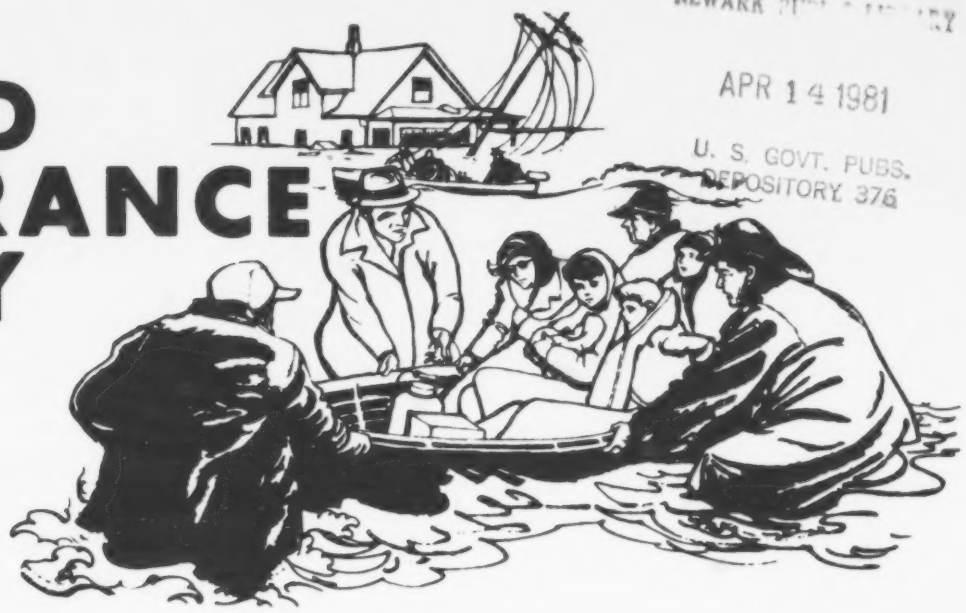
FLOOD INSURANCE STUDY



TOWNSHIP OF HASTINGS, MICHIGAN

BARRY COUNTY

DECEMBER 15, 1980

federal emergency management agency
federal insurance administration

COMMUNITY NUMBER - 260648

FEM 1.209:

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PUBLISHED SEPARATELY:

Flood Insurance Rate Map Index
Flood Insurance Rate Map

FLOOD INSURANCE STUDY

TOWNSHIP OF HASTINGS,
BARRY COUNTY, MICHIGAN

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study investigates the existence and severity of flood hazards in the Township of Hastings, Barry County, Michigan, and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study will be used to convert the Township of Hastings to the regular program of flood insurance by the Federal Insurance Administration (FIA). Local and regional planners will use this study in their efforts to promote sound flood plain management.

In some states or communities, flood plain management criteria or regulations may exist that are more restrictive or comprehensive than those on which these Federally-supported studies are based. These criteria take precedence over the minimum Federal criteria for purposes of regulating development in the flood plain, as set forth in the Code of Federal Regulations at 44 CFR, 60.1 (d). In such cases, however, it shall be understood that the state (or other jurisdictional agency) shall be able to explain these requirements and criteria.

1.2 Authority and Acknowledgements

The source of authority for this Flood Insurance Study is the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The hydrologic and hydraulic analyses for this study were performed by the U.S. Army Corps of Engineers, Detroit District, for the Federal Insurance Administration, under Inter-Agency Agreement No. IAA-H-10-77, Project Order No. 16, amended by Amendment No. 2. This study was completed in September 1978.

1.3 Coordination

Streams requiring approximate and detailed study were identified at the initial coordination meeting attended by personnel of the U.S. Army Corps of Engineers (COE), Detroit District; and the FIA, and officials of the Township of Hastings on September 7, 1976. Hydrology reports were prepared and submitted to the Michigan Department of Natural Resources, and were approved for streamflows on June 13, 1978.

On July 24, 1980, the results of the work by the Study Contractor were reviewed and accepted at a final coordination meeting attended by representatives of the FIA, the State Coordinating Agency, and the COE, and officials and citizens from the Township of Hastings.

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the incorporated area of the Township of Hastings, Barry County, Michigan. The area of study is shown on the Vicinity Map (Figure 1).

The areas studied by detailed methods were selected with priority given to all known flood hazard areas, and areas of projected development or proposed construction for the next five years, through September 1983.

Approximate methods of analysis were used to study those areas having a low development potential or minimal flood hazards. The scope and methods of study were proposed to and agreed upon by the FIA and the Township of Hastings.

Floods caused by the overflow of the Thornapple River within the corporate limits and Fall Creek from the City of Hastings southern corporate limit to Broadway Street were studied in detail. Flooding on Cedar Creek, Butler Creek, the Carter-Leach Lake system, and the remainder of Fall Creek within the corporate limits were studied by approximate methods.

2.2 Community Description

The Township of Hastings is located slightly north of the center of Barry County in southwestern Michigan. The Township of Hastings is bordered on the west by the incorporated areas of the City of Hastings and the Township of Rutland, on the north by the Township of Carlton, on the east by the Township of Castleton, and on the south by the Township of Baltimore. The Cities of Grand Rapids, Lansing, Battle Creek, and Kalamazoo are within a 40-mile radius of the Township of Hastings. The population, according to the 1970 Census figures, was 2,159 (Reference 1).

The climate in Michigan is characteristically humid continental. The average annual temperature is 48 degrees Fahrenheit (F.). Extremes in average monthly temperatures have ranged from 37.2 degrees F. to 58.8 degrees F. Precipitation averages 32.34 inches a year with recorded extremes of 45.94 inches maximum to 19.11 inches minimum. Snowfall averages 41.8 inches per year with a recorded maximum of 56.6 inches and a minimum of 20.9 inches (Reference 2).

The topography in the vicinity of the Township of Hastings varies from predominantly rolling or hilly, glacial, morainic material to gently

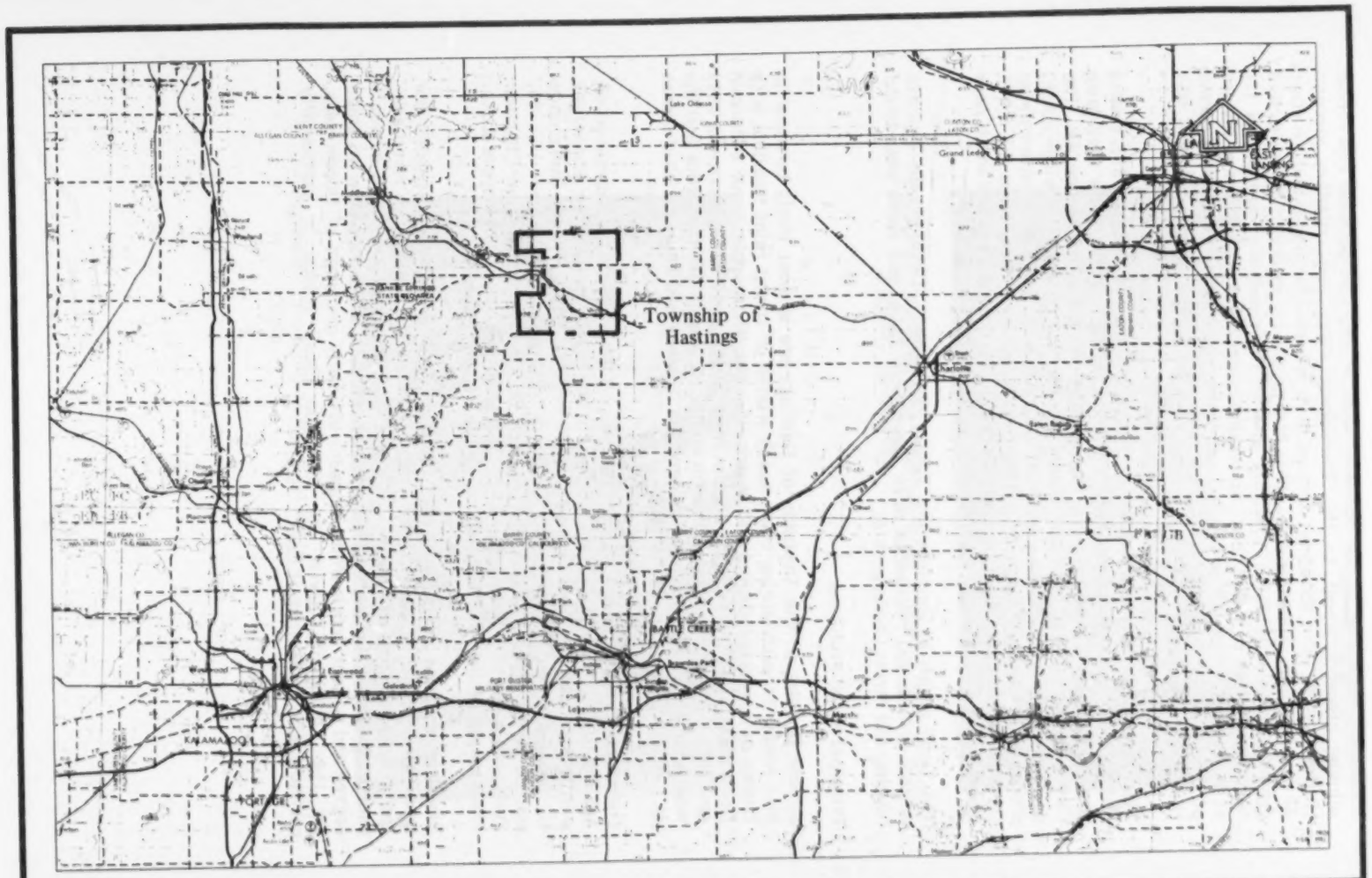

FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

TOWNSHIP OF HASTINGS, MI
(BARRY CO.)

APPROXIMATE SCALE
8 0 8 16 24 MILES

VICINITY MAP

undulating till plains in the northeast quarter and flat outwash and recent alluvial plains adjacent to the Thornapple River and tributary streams (Reference 3). The tributary streams have not yet attained a mature stage of development. Many swampy areas and ponds are evidence of inefficient drainage both within the township and in the headwater areas. In the headwater areas of Fall Creek, for example, drainage is broken and ponded at low flows. The Carter-Leach Lake watercourse, in the northeast corner of the township, is part of a chain of lakes draining from east to west into the Thornapple River.

The Thornapple River, which drains an area of approximately 385 square miles at the U.S. Geological Survey (USGS) gaging station below McKeown Road, flows west by northwest through the township (Reference 4). The Carter-Leach Lake watercourse enters the Thornapple River from the north, downstream of the Hastings-Rutland township line; Fall Creek enters from the south through the City of Hastings; Butler Creek enters from the north through northeastern Hastings; and Cedar Creek enters from the south near Quimby, Michigan, in the southeastern portion of the township.

The flood plains in Hastings are lightly developed. Development consists largely of seasonal residences near Thornapple Lake, and some year-round housing and farms (Reference 4).

2.3 Principal Flood Problems

Severe flooding in the Township of Hastings are is most likely to occur in late winter or early spring when heavy winter or spring rains combine with frozen or saturated ground and snowmelt. The Thornapple River exceeded flood state at a USGS gaging station near Hastings 12 times between 1945 and 1976. Floods occuring in March and April were more numerous and the most severe. Floods also have occurred in January and February (Reference 4).

The three greatest floods on the Thornapple River since 1945 occurred on April 7, 1947; April 21, 1975; and March 21, 1948. Respective discharges were 6,810 cubic feet per second (cfs), 5,040 cfs, and 4,890 cfs (Reference 4). The estimated return period for floods of these magnitudes are 100, 22, and 20 years, respectively. Areas which flood often include the Charlton Park area along the Thornapple River and areas bordering Thornapple Lake. Photographs of the 1975 flood are shown in Figures 2 and 3.

Flooding problems along the Thornapple River and the tributary streams are intensified by heavy brush, trees, and other material along the riverbanks and flood plains. Numerous bridges on the Thornapple River and culverts and bridges on Fall Creek and the other tributaries restrict flow to some degree and collect debris which impedes efficient discharge of floodwaters. On the Thornapple River, the Charlton Road bridge is particularly restrictive to main channel flow.

Figure 2 - Flooding near Charlton Road bridge on the Thornapple River, April 1975.

Figure 3 - Flooding on the west shore of Thornapple Lake, April 1975.

2.4 Flood Protection Measures

There are no flood protection structures on the Thornapple River or Fall Creek and the other tributaries in the Township of Hastings. There are no existing zoning ordinances concerning flood plain management.

3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude which are expected to be equalled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for flood plain management and for flood insurance premium rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10, 2, 1, and 0.2 percent chance, respectively, of being equalled or exceeded during any year. Although the recurrence interval represents the long term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than one year are considered. For example, the risk of having a flood which equals or exceeds the 100-year flood (one percent chance of annual occurrence) in any 50-year period is about 40 percent (four in ten), and for any 90-year period, the risk increases to about 60 percent (six in ten). The analyses reported here reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for floods of the selected recurrence intervals for each flooding source studied in detail affecting the community.

For the Thornapple River, discharge values developed for the Nashville-Hastings Special Flood Hazard Information Study (Reference 4) were adopted. These discharge values were determined according to U.S. Water Resources Bulletin No. 17, Guidelines for Determining Flood Flow Frequency (Reference 5). A regional generalized skew coefficient of -0.3 was computed. Flood frequencies on the Thornapple River were based upon 31 years of record at the USGS gage just downstream of the McKeown Road bridge near Hastings. Discharges in the reaches through the Township of Hastings, downstream of the gage, were estimated by adding flows computed by a discharge-drainage area relationship. For Fall Creek, an ungaged stream, a regional discharge-drainage area relationship was developed using existing gage records in the region and the least squares method to determine a curve of best fit (Reference 5).

Peak discharges for the 10-, 50-, 100-, and 500-year floods of each flooding source studied in detail in the community are shown in Table 1.

TABLE 1 - SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (SQ MILES)	PEAK DISCHARGE (CFS) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
THORNAPPLE RIVER					
Downstream study limits	394	4,310	6,110	6,930	8,760
At USGS gage station below McKeown Road	385	4,200	6,000	6,800	8,600
FALL CREEK					
Upstream study limit	23	320	415	455	540

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of the streams in the community were carried out to provide estimates of the elevations of the floods of the selected recurrence intervals along each flooding source studied in detail.

Cross sections for the backwater analyses of the Thornapple River, which were extended from aerial photographs, were taken from the Nashville-Hastings Special Flood Hazard Information Study (Reference 4). The channel portions of the cross sections were obtained by field measurements. Cross sections for the backwater analyses of Fall Creek were developed for this study and were obtained by field measurement. All bridges, culverts, and dams were field checked to obtain elevation data and structural geometry.

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway was computed (Section 4.2), selected cross section locations are also shown on the Flood Boundary and Floodway Map (Exhibit 2).

Channel roughness factors (Manning's "n") used in the hydraulic computations were based on field observation, examination of aerial photographic coverage and, in the case of Thornapple River, the analysis of high water marks of the April 1975 flood (Reference 4). Channel roughness values range from 0.03 to 0.06 on the Thornapple River and from 0.06 to 0.19 for the overbank areas. Channel roughness values on Fall Creek are 0.03 and overbank roughness values range from 0.04 to 0.15.

Starting elevations for the Thornapple River and Fall Creek were adopted from the City of Hastings Flood Insurance Study using backwater computations at the city-township corporate limits (Reference 6).

Water-surface elevations of floods of the selected recurrence intervals were computed through use of the COE HEC-2 step-backwater computer program (Reference 7). Flood profiles were drawn showing computed water-surface elevations for floods of the selected recurrence intervals (Exhibit 1).

For Butler Creek, Cedar Creek, the Carter-Leach Lake watercourse, and the upstream portion of Fall Creek studied by approximate methods, the boundary of the 100-year flood was developed from normal depth calculations. Calculated depths and photogrammetric methods were used to determine the elevation of the flood along the stream, througout the project area (Reference 8).

The hydraulic analyses for this study are based only on the effects of unobstructed flow. The flood elevations as shown on the profiles are, therefore, considered valid only if hydraulic structures, in general, remain unobstructed and if channel and overbank conditions remain essentially the same as ascertained during this study.

All elevations are referenced from National Geodetic Vertical Datum of 1929 (NGVD); elevation reference marks used in the study are shown on the maps.

4.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

The National Flood Insurance Program encourages state and local governments to adopt sound flood plain management programs. Therefore, each Flood Insurance Study includes a flood boundary map designed to assist communities in developing sound flood plain management measures.

4.1 Flood Boundaries

In order to provide a national standard without regional discrimination, the 100-year flood has been adopted by the FIA as the base flood for purposes of flood plain management measures. The 500-year flood is employed to indicate additional areas of flood risk in the community. For each stream studied in detail, the boundaries of the 100-year and the 500-year floods have been delineated using the elevations determined at each cross section; between cross sections the boundaries were interpolated using planimetric maps at a scale of 1:6000, with a contour interval of five feet (Reference 8). The approximate flood boundaries for Butler Creek, Cedar Creek, the Carter-Leach Lake watercourse, and the upstream portion of Fall Creek were taken from the above-referenced maps.

The boundaries of the 100- and 500-year floods are shown on the Flood Boundary and Floodway Map (Exhibit 2). Small areas within the flood boundaries may lie above the flood elevations and, therefore, not be subject to flooding; owing to lack of detailed topographical information or to limitations of the map scale, such areas are not shown. In cases where the

100-year and the 500-year flood boundaries are close together, only the 100-year boundary has been shown.

4.2 Floodways

Encroachment on flood plains, such as artificial fill, reduces the flood-carrying capacity, increases the flood heights of streams, and increases flood hazards in areas beyond the encroachment itself. One aspect of flood plain management involves balancing the economic gain from flood plain development against the resulting increase in flood hazard. For purposes of the National Flood Insurance Program, the concept of a floodway is used as a tool to assist local communities in this aspect of flood plain management. Under this concept, the area of the 100-year flood is divided into a floodway and a floodway fringe. The floodway is the channel of a stream plus any adjacent flood plain areas that must be kept free of encroachment in order that the 100-year flood may be carried without substantial increases in flood heights. Minimum standards of the FIA limit such increases in flood heights to 1.0 foot, provided that hazardous velocities are not produced. In Michigan, though, under Michigan Act 245, Public Acts of 1929, as amended by Act 167, Public Acts of 1968 (Reference 9), encroachment in the flood plain is limited to that which will cause only an insignificant increase in flood heights. Thus, at the recommendation of the Bureau of Water Management, a floodway having no more than a 0.1-foot surcharge has been delineated for this study.

The floodways presented in this study were computed on the basis of equal conveyance reduction from each side of the flood plain. The results of these computations were tabulated at selected cross sections for each stream segment for which a floodway was computed (Table 2).

As shown on the Flood Boundary and Floodway Map (Exhibit 2), the floodway boundaries were determined at cross sections; between cross sections, the boundaries were interpolated. In cases where the boundaries of the floodway and the 100-year flood are either close together or collinear, only the floodway boundary has been shown.

The area between the floodway and the boundary of the 100-year flood is termed the floodway fringe. The floodway fringe thus encompasses the portion of the flood plain that could be completely obstructed without increasing the water-surface elevation of the 100-year flood more than 0.1 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to flood plain development are shown in Figure 4.

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION		
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC.)	WITH FLOODWAY (NGVD)	WITHOUT FLOODWAY (NGVD)	DIFFERENCE
THORNAPPLE RIVER							
A	0	555[2]	2188	3.2	785.2	785.1	0.1
B	1825	420	2793	2.5	787.4	787.3	0.1
C	2625	636	3198	2.2	787.8	787.7	0.1
D	4350	1517	5837	1.2	788.5	788.4	0.1
E	5950	818	4913	1.4	789.1	789.0	0.1
F	8350	629	3022	2.3	790.1	790.0	0.1
G	10,250	473	2544	2.7	791.5	791.4	0.1
H	11,600	732	3956	1.8	793.3	793.2	0.1
I	14,000	1416	6885	1.0	794.2	794.1	0.1
J	15,675	912	3535	2.0	794.7	794.6	0.1
K	17,200	601	4017	1.7	795.7	795.6	0.1
L	18,235	690	3997	1.7	796.3	796.2	0.1
M	18,825	272	1816	3.8	796.4	796.3	0.1
N	20,450	232	1744	4.0	797.9	797.8	0.1
O	22,565	660	3779	1.8	799.9	799.8	0.1
P	23,580	439	2726	2.5	800.2	800.1	0.1
Q	24,750	364	3474	2.0	801.0	800.9	0.1
R	25,200	350	3353	2.0	801.2	801.1	0.1
S	27,335	400	4745	1.4	801.8	801.7	0.1
T	28,375	350	4461	1.5	801.8	801.7	0.1
U	29,915	836	7720	0.9	803.1	803.0	0.1
V	32,025	1128	15,519	0.4	803.1	803.0	0.1
W	34,325	1382	15,883	0.4	803.1	803.0	0.1
X	36,800	2993[2]	62,962	0.1	803.1	803.0	0.1

[1]FEET ABOVE CORPORATE LIMITS
[2]THIS WIDTH EXTENDS BEYOND CORPORATE LIMITS

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

TOWNSHIP OF HASTINGS, MI
(BARRY CO.)

FLOODWAY DATA

THORNAPPLE RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION		
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC.)	WITH FLOODWAY (NGVD)	WITHOUT FLOODWAY (NGVD)	DIFFERENCE
FALL CREEK							
A	0	203	309	1.5	813.5	813.4	0.1
B	2270	241	466	1.0	814.7	814.6	0.1
C	2750	105	110	4.1	815.7	815.7	0.0
D	4368	65	138	3.3	823.6	823.6	0.0
E	5400	65	131	3.5	831.3	831.3	0.0
F	8068	196	793	0.6	840.3	840.2	0.1
G	8572	208	681	0.7	841.0	841.0	0.0
H	12,300	497	918	0.5	842.1	842.1	0.0
I	13,650	236	259	1.8	843.6	843.5	0.1

[1]FEET ABOVE CORPORATE LIMITS

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

TOWNSHIP OF HASTINGS, MI
(BARRY CO.)

FLOODWAY DATA

FALL CREEK

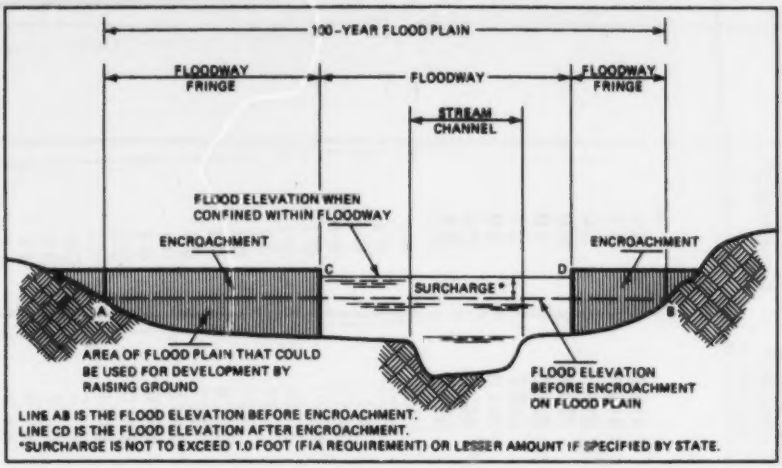
100-YEAR FLOOD PLAIN
FLOODWAY FRINGE
FLOODWAY
FLOODWAY FRINGE
STREAM CHANNEL
FLOOD ELEVATION WHEN CONFINED WITHIN FLOODWAY
ENCROACHMENT
ENCROACHMENT
C
D
SURCHARGE *
A
B
AREA OF FLOOD PLAIN THAT COULD BE USED FOR DEVELOPMENT BY RAISING GROUND
FLOOD ELEVATION BEFORE ENCROACHMENT ON FLOOD PLAIN
LINE AB IS THE FLOOD ELEVATION BEFORE ENCROACHMENT.
LINE CD IS THE FLOOD ELEVATION AFTER ENCROACHMENT.
*SURCHARGE IS NOT TO EXCEED 1.0 FOOT (FIA REQUIREMENT) OR LESSER AMOUNT IF SPECIFIED BY STATE.

FIGURE 4 - Floodway Schematic

The floodways in this report are recommended to local agencies as minimum standards that can be adopted or that can be used as a basis for additional studies.

5.0 INSURANCE APPLICATION

In order to establish actuarial insurance rates, the FIA has developed a process to transform the data from the engineering study into flood insurance criteria. This process includes the determination of reaches, Flood Hazard Factors (FHF), and flood insurance zone designations for each flooding source affecting the Township of Hastings.

5.1 Reach Determinations

Reaches are defined as lengths of watercourses having relatively the same flood hazard, based on the average weighted difference in water-surface elevations between the 10- and 100-year floods. This difference does not have a variation greater than that indicated in the following table for more than 20 percent of the reach.

Average Difference Between 10- and 100-year Floods	Variation
Less than 2 feet	0.5 foot
2 to 7 feet	1.0 foot
7.1 to 12 feet	2.0 feet
More than 12 feet	3.0 feet

The locations of the reaches determined for the Township of Hastings are shown on the Flood Profiles (Exhibit 1) and are summarized in the Flood Insurance Zone Data Table (Table 3).

5.2 Flood Hazard Factors

The FHF is used to correlate flood information with insurance rate tables. Correlations between property damage from floods and their FHFs are used to set actuarial insurance premium rate tables based on FHFs from 005 to 200.

The FHF for a reach is the average weighted difference between the 10- and 100-year flood water-surface elevations expressed to the nearest 0.5 foot, and shown as a three-digit code. For example, if the difference between water-surface elevations of the 10- and 100-year floods is 0.7 foot, the FHF is 005; if the difference is 1.4 feet, the FHF is 015; if the difference is 5.0 feet, the FHF is 050. When the difference between the 10- and 100-year water-surface elevations is greater than 10.0 feet, accuracy for the FHF is to the nearest foot.

5.3 Flood Insurance Zones

After the determination of reaches and their respective FHFs, the entire incorporated area of the Township of Hastings was divided into zones, each having a specific flood potential or hazard. Each zone was assigned one of the following flood insurance zone designations:

Zone A:	Special Flood Hazard Areas inundated by the 100-year flood, determined by approximate methods; no base flood elevations are shown or FHFs determined.
Zones A1, A4, A5:	Special Flood Hazard Areas inundated by the 100-year flood, determined by detailed methods; base flood elevations are shown, and zones subdivided according to FHF.
Zone B:	Areas between the Special Flood Hazard Area and the limits of the 500-year flood, including areas of the 500-year flood plain that are protected from the 100-year flood by dike, levee, or other water control structure; or areas subject to certain types of 100-year shallow flooding where depths are less than 1.0 foot; and areas subject to 100-year flooding from sources with drainage areas less than 1 square mile. Zone B is not subdivided.

Zone C: Areas of minimal flooding.

Table 3, "Flood Insurance Zone Data," summarizes the flood elevation differences, FHFs, flood insurance zones, and base flood elevations for each flooding source studied in detail in the community.

5.4 Flood Insurance Rate Map Description

The Flood Insurance Rate Map for the Township of Hastings is, for insurance purposes, the principal result of the Flood Insurance Study. This map (published separately) contains the official delineation of flood insurance zones and base flood elevation lines. Base flood elevation lines show the locations of the expected whole-foot water-surface elevations of the base (100-year) flood. This map is developed in accordance with the latest flood insurance map preparation guidelines published by the FIA.

6.0 OTHER STUDIES

A Special Flood Hazard Information Study was conducted for a reach of the Thornapple River which begins at the Hastings-Rutland township line and proceeds upstream a distance of 19.6 river miles through the Cities of Hastings and Nashville to the Barry-Eaton county line (Reference 4). The results of the study were not finalized at the time of this report. The study is the basis for the Township of Hastings Flood Insurance Study and results of the two studies will coincide exactly.

A Flood Insurance Study for the City of Hastings, Michigan is in agreement with this study (Reference 6). That study includes the incorporated area of the City of Hastings which is located in the northwestern area of the Township of Hastings.

A Flood Hazard Boundary Map has been published by the Federal Insurance Administration (Reference 10). The differences between the Flood Hazard Boundary Map and this study are justified due to the more detailed nature of this Flood Insurance Study.

This report either supersedes or is compatible with all previous studies published on streams studied in this report and should be considered authoritative for the purposes of the National Flood Insurance Program.

7.0 LOCATION OF DATA

Survey, hydrologic, hydraulic and other pertinent data used in this study can be obtained by contacting the Insurance and Mitigation Division, Federal Emergency Management Agency, One North Dearborn Street, Chicago, Illinois 60602.

FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1.0% (100-YEAR) FLOOD AND			FLOOD HAZARD FACTOR	ZONE	BASE FLOOD ELEVATION[3] (NGVD)
		10% (10-YEAR)	2% (50-YEAR)	0.2% (500-YEAR)			
THORNAPPLE RIVER							
REACH 1	0003,0004,0006	–1.9	–0.5	1.1	020	A4	VARIES–SEE MAP
REACH 2	0004,0006	–2.7	–1.0	1.4	025	A5	VARIES–SEE MAP
FALL CREEK							
REACH 1	0003,0005	–0.5	–0.1	0.2	005	A1	VARIES–SEE MAP

[1]FLOOD INSURANCE RATE MAP PANEL
[2]WEIGHTED AVERAGE
[3]ROUNDED TO NEAREST FOOT

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

TOWNSHIP OF HASTINGS, MI
(BARRY CO.)

FLOOD INSURANCE ZONE DATA

THORNAPPLE RIVER - FALL CREEK

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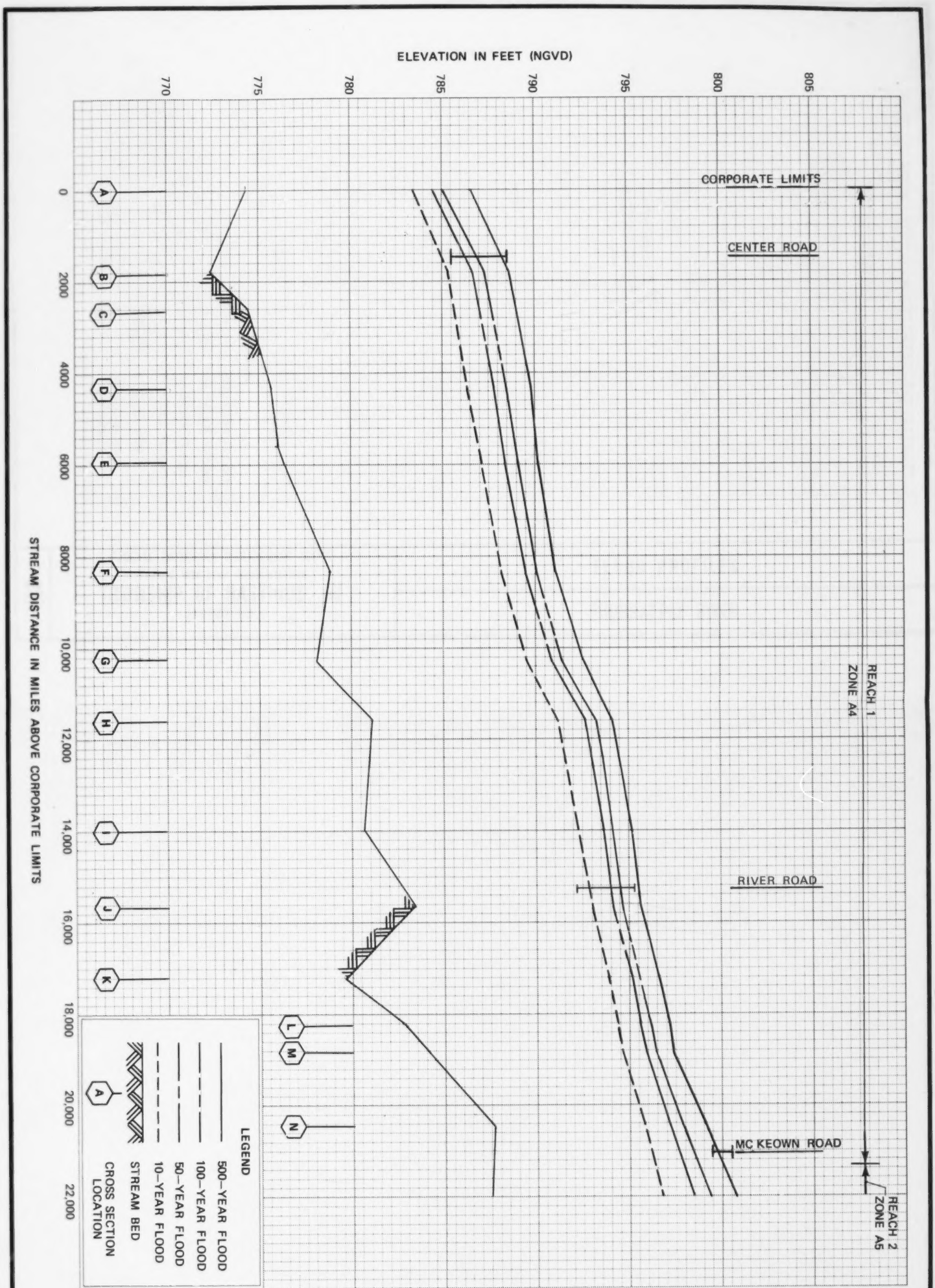
6. Federal Emergency Management Agency, Federal Insurance Administration, Flood Insurance Study, City of Hastings, Michigan, (in progress).

7. U.S. Army Corps of Engineers, Hydrologic Engineering Center, HEC-2 Water-Surface Profiles, Users Manual, Davis, California, November 1976.

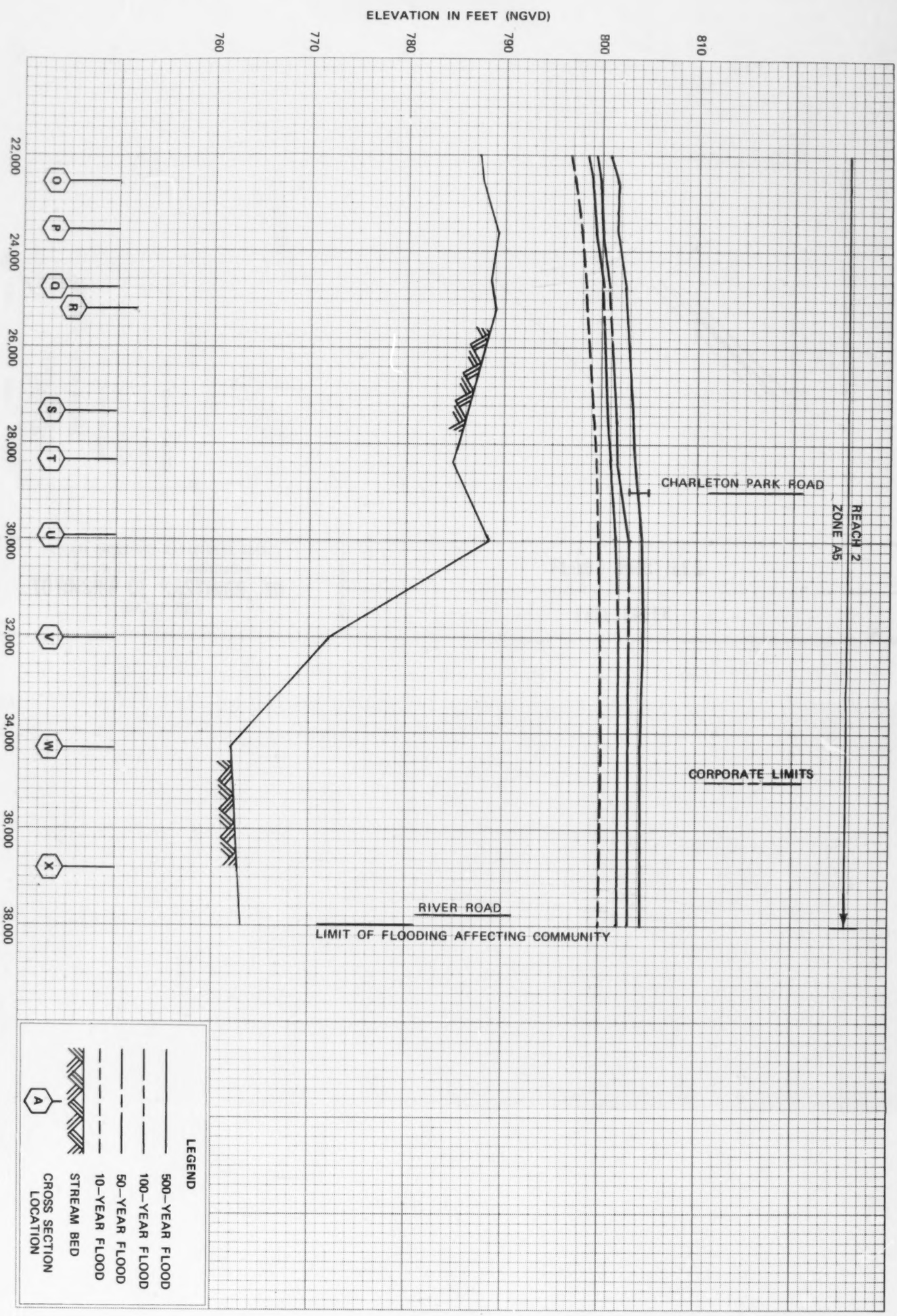
8. Abrams Aerial Survey Corporation, Planimetric Map, Scale 1:6000, Contour Interval five feet: Township of Hastings, Michigan, 1979.

9. State of Michigan, Flood Plain Control Act of 1968, Act 245, P.A. 1929 as amended by Act 167, P.A. 1968, Michigan Water Resources Commission, Lansing, Michigan, 1968.

10. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Hazard Boundary Map, Township of Hastings, Michigan, December 1977.



01P	FEDERAL EMERGENCY MANAGEMENT AGENCY Federal Insurance Administration **TOWNSHIP OF HASTINGS, MI** (BARRY CO.)	**FLOOD PROFILES** **THORNAPPLE RIVER**

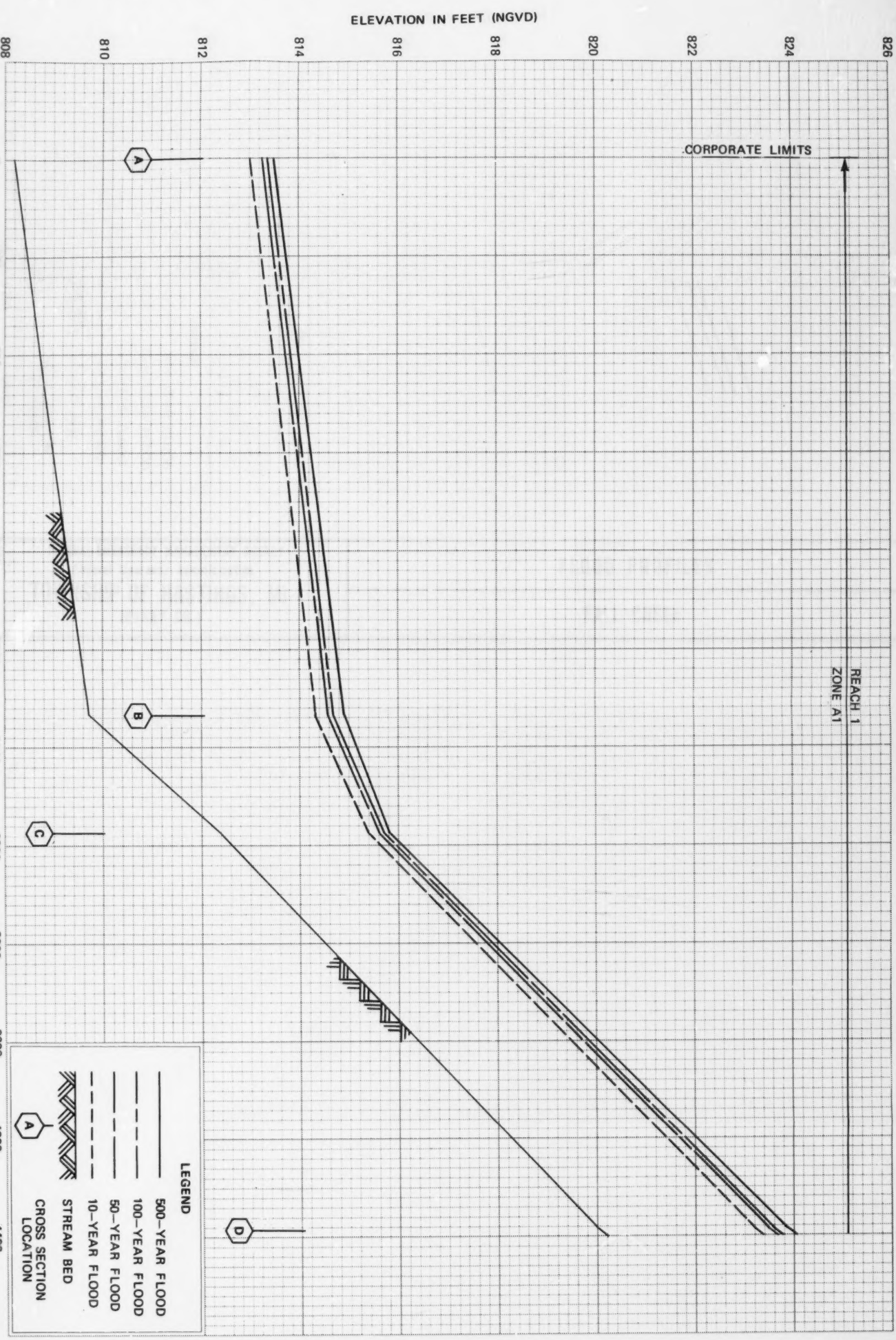


02P

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration
TOWNSHIP OF HASTINGS, MI
(BARRY CO.)

FLOOD PROFILES

THORNAPPLE RIVER

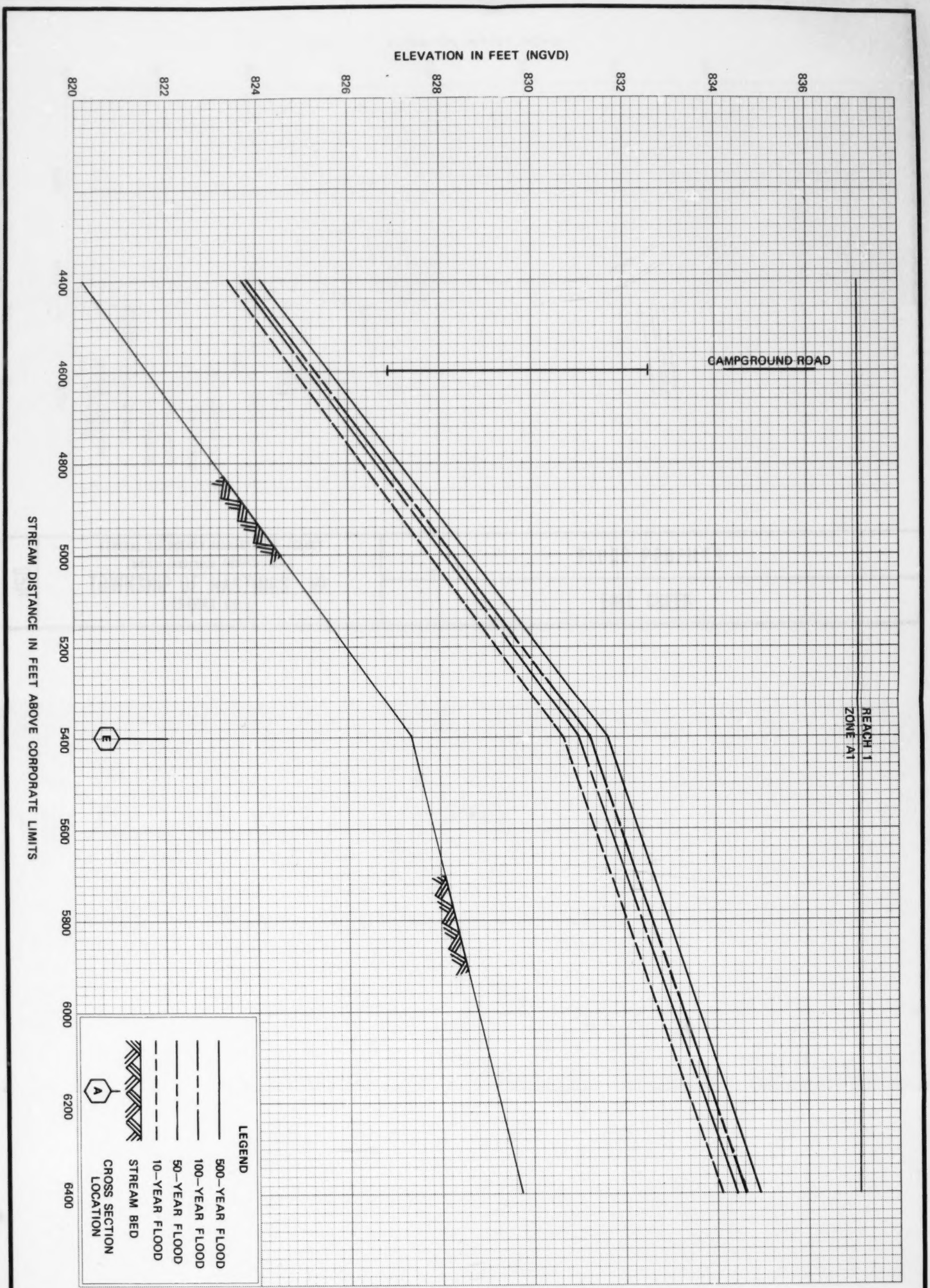


03P

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration
TOWNSHIP OF HASTINGS, MI
(BARRY CO.)

FLOOD PROFILES

FALL CREEK



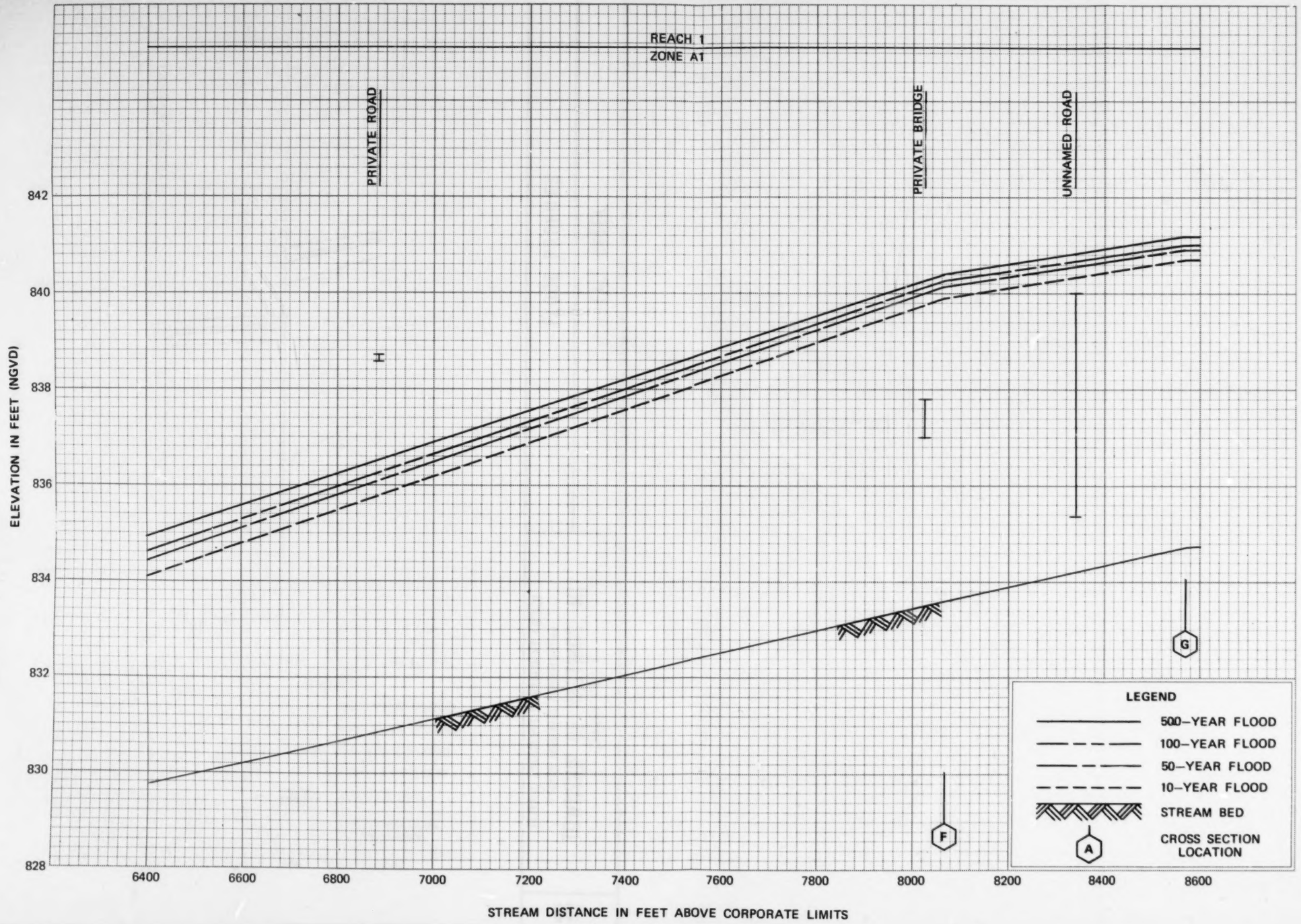
04P

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

TOWNSHIP OF HASTINGS, MI
(BARRY CO.)

FLOOD PROFILES

FALL CREEK



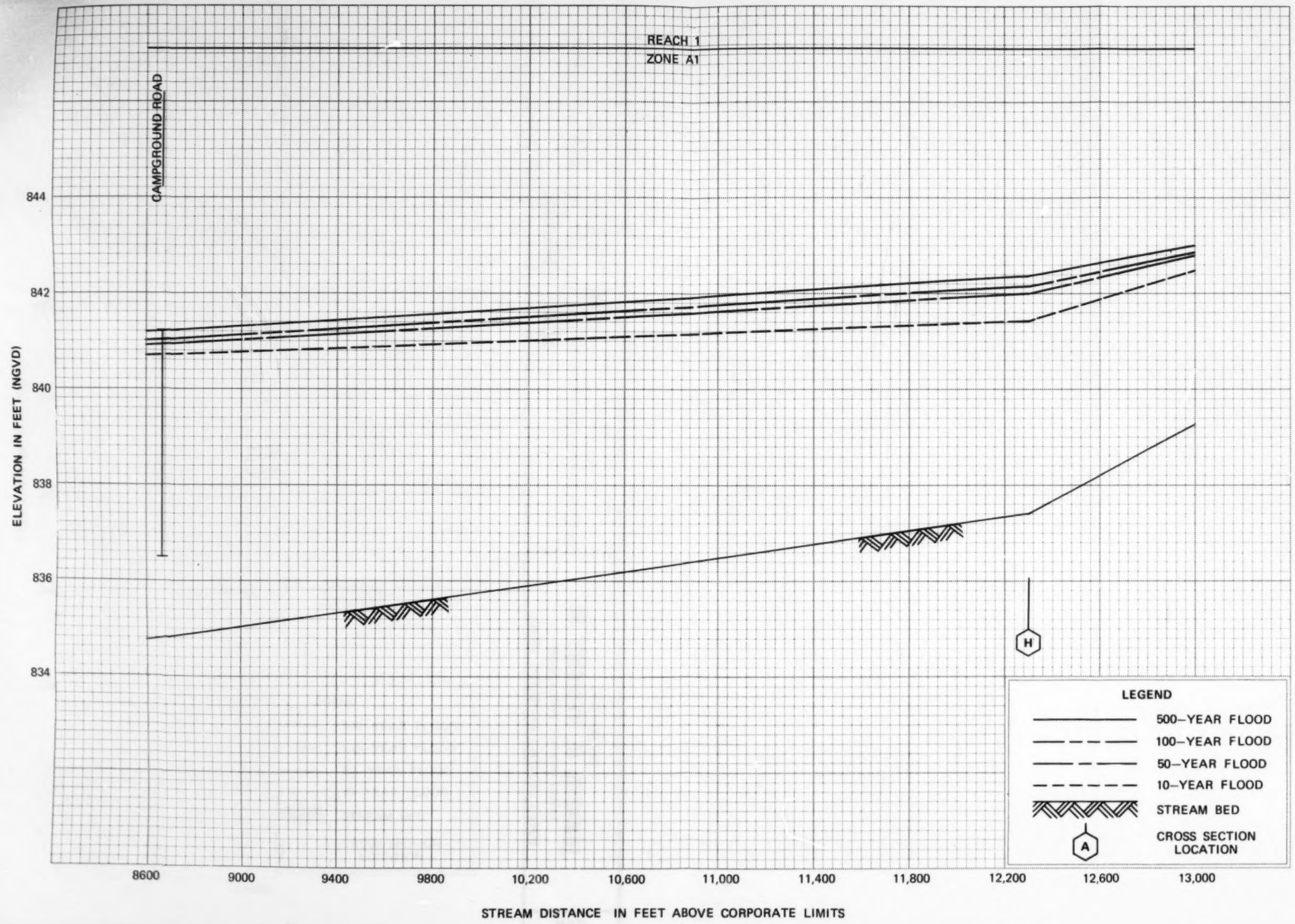
FLOOD PROFILES

FALL CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

TOWNSHIP OF HASTINGS, MI
(BARRY CO.)

05P



FLOOD PROFILES

FALL CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY
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TOWNSHIP OF HASTINGS, MI
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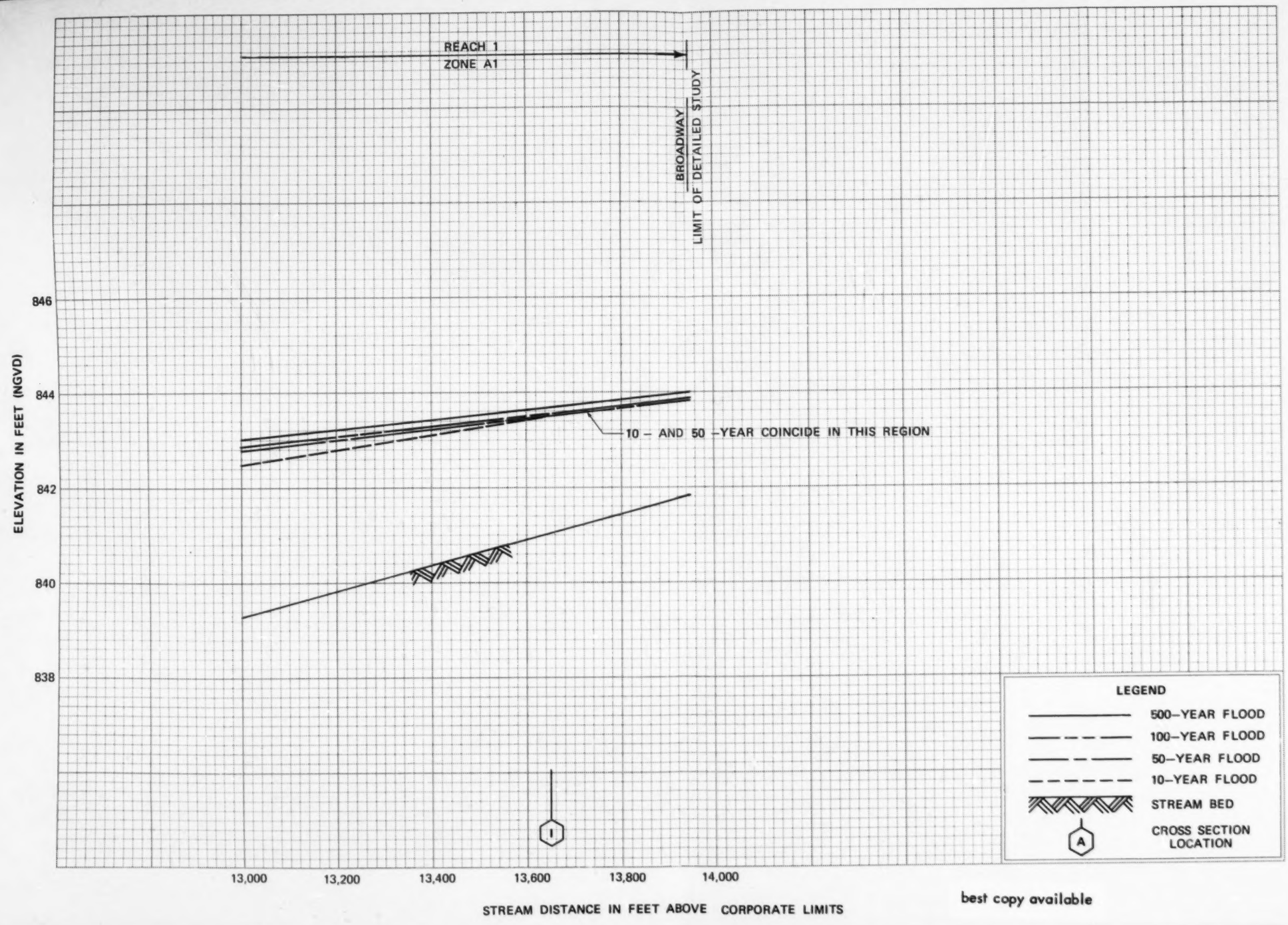

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FLOOD PROFILES

FALL CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

TOWNSHIP OF HASTINGS, MI
(BARRY CO.)

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